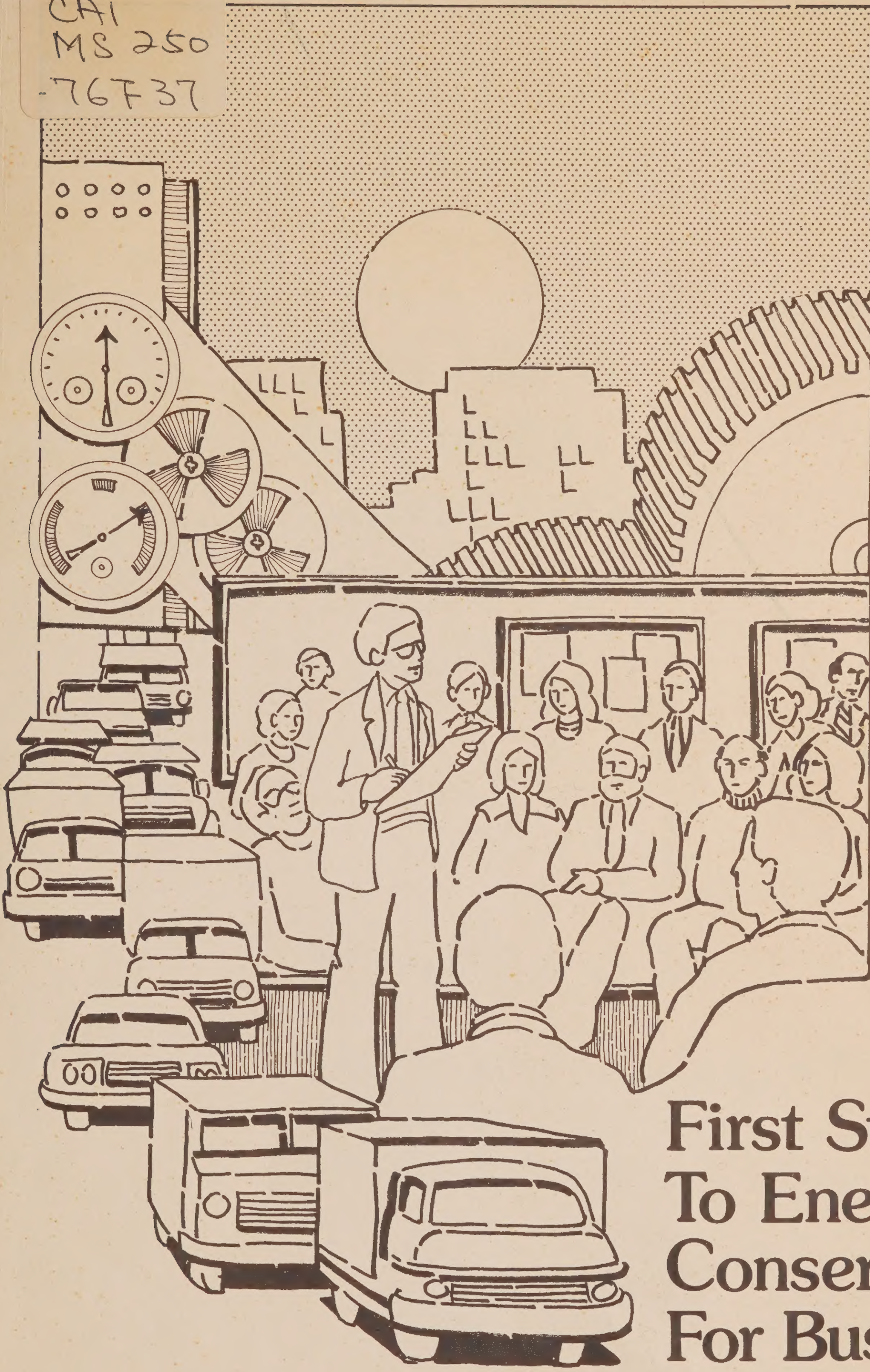

First Steps To Energy Conservation For Business

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

First Steps To Energy Conservation For Business

Office of Energy Conservation

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Ottawa, Ontario

March, 1976

PURPOSE OF THIS BOOKLET

This booklet does not pretend to advise or enlighten those companies who have long pursued energy efficiency as a goal in itself, nor to trumpet the downfall of those businesses who ignore the warning signals and wait to be compelled to conserve energy. Rather, we wish to alert those companies which remain unconscious of a growing trend towards energy efficiency in business so that they may remain competitive as the availability of abundant supplies of energy declines and the price asked for them increases.

This booklet is an introduction to an energy conservation program for your business; it is the first in a series of booklets which will deal with various industries and processes on an individual basis and which we expect to publish periodically over the next few months.

In this publication, we are primarily concerned with the organization of an energy conservation committee and the execution of an energy audit. The purpose of an energy audit is to identify those areas where energy is being wasted and, therefore, to spotlight those areas with the largest potential for savings. The lists of suggested corrective actions which follow focus mostly (but not exclusively) on housekeeping measures. Process changes which are the next step in a conservation program are much more industry-specific and will be dealt with in future publications.

Initially, to train the personnel and organize the committee might require some redirection of resources and some rescheduling of worktime. However, when the conservation program is in full swing, the time and expertise required to complete the forms rapidly declines to the point where a line supervisor can keep it going on about half an hour a day.

The conservation program and the action suggestion list in this publication are culled from programs in large businesses which have energy experts capable of measuring and demonstrating the value of these ideas. The basic intent of this publication is to simplify these programs so that the smaller businesses might benefit from the knowledge gained through experience.

We all stand to benefit from the most efficient utilization of our resources — the Canadian business community's strength and the surety of continued employment depend upon it.

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SECTION I

THE CRISIS

1) Problem or opportunity?

Energy — how it is to be obtained and how it is to be used — has emerged as one of the major public questions of our time. With the growing complexity of the industrial economy, and the modern trend towards compulsive consumption, the rate of demand for energy has been accelerating.

The sources of recoverable energy now employed are already being depleted. Owing to the increased demand there is grave concern as to whether future supplies will be available, and whether they are exploitable at costs that will not negate our other aspirations. How will increased demand coupled with decreased convenience of supply affect our national environment and our quality of life?

There are many difficult questions. We must soon decide at what rate we are to develop our frontier sources of oil and gas, with all the implications that such development has for the lives of those who make their homes in those regions, for the environment of those areas and for the national economy. Most of the major, accessible sources of hydroelectric potential have been or are now being harnessed; we must make decisions as to what form of thermal generation, fossil fuel or nuclear, is to meet the future demand for electric power. Decisions now as to how we employ our finite resources will determine our ability to respond to the problems that will affect our life and that of future generations.

Until recently, energy policy in Canada meant simply how to find and deliver enough energy to meet expanding demand. Henceforth, attempts to limit or manage the growth of demand for energy will be, in principle, as significant as attempts to augment supply.

The placing of demand limitations on an equal footing with supply augmentation is a logical approach. From our "a priori" argument, a supply-demand gap can be filled either by increasing supply or by cutting demand. In Canada, evidence is strong that many energy problems can be resolved with less expense and less risk by focusing on policies to curb demand rather than continuing to rely almost exclusively on increasing supply.

2) Canada's Energy Consumption

Over a 10-year period, from 1961 to 1971, the energy consumed by the average Canadian increased by about 50%. In absolute terms this was an enormous increase. If the rate of growth for energy remained constant, without accelerating, every decade the demand for energy would increase by 50%. This magnitude of increase cannot long be sustained without causing major political, economic and social disruptions. Also significant is the fact that, when compared with the gross national product, energy efficiency remained about the same. Despite the substantial advances in technology, there were enough offsetting factors (i.e. lower quality energy sources, increases in the number of goods produced,the conversion to low quality disposible goods and the increase in consumption) so that the efficiency of energy use remained about constant.

Many sectors of the economy have remained stable in relative terms; nevertheless, there are enormous absolute increases in each case. Two very significant figures are the large relative increases for the commercial sector and the nearly 50% increase for the energy supplies industries. The latter represents the fact that our modern sources of energy are often harder to find, farther away, and are more difficult to extract and refine.

Another way to look at our energy consumption is by international comparison. Canada is clearly one of the most energy intensive countries in the world especially when compared with a country such as Sweden, which has a similar income per person and a comparable climate. Indeed, the range in per capita energy consumption among industrial countries suggests that much greater

efficiencies are possible without major alterations to our quality of life.

3) Why Conserve Energy?

a) Resources

In terms of availability of resources, it appears that our best years are just behind us. Our ability to produce and delivery petroleum is likely to be declining from here on. If current trends hold fast, Canada as a whole will continue to be a net importer of petroleum. Even though more oil will be discovered, there is no indication that resources in the ground will grow enough to alter significantly this picture. Much of the same is true for natural gas as for oil. Although discoveries have been made in the Arctic and offshore they have yet to be proven as deposits that can be exploited and delivered at a reasonable cost.

When one considers coal and tar sands, although abundant, the environmental and economic problems of mining and then transforming them into useful forms are enormous.

In sum, the traditional supplies of oil and gas on which we have relied most heavily in the past are not widely available for the future, especially when compared with current growth in demand.

b) Capital Requirements

A second reason for conservation which is implicit in the section on resources is the tremendous costs of future development. It has been estimated that capital requirements for the next decade alone will amount to more than $110 billion, or about $20,000 for every Canadian family.

To obtain these sums requires a doubling of the proportion of GNP going to energy investments. This means investment that might otherwise be destined for schools, homes, manufacturing, etc. will be redirected to the exploitation of our natural resources.

No matter which type of energy we consider developing for the future, the costs will be immense. Capital requirements to develop any one alternate source are available. Because of rising consumption, however, we may need to develop the alternate sources simultaneously. At a time when other countries are attempting to attain energy self-sufficiency, the capital may be available only through foregoing our other aspirations. In contrast, capital costs for many, though not all, conservation projects are very low by comparison.

c) Energy Costs

As we move to lower quality and more remote sources, more and more energy will be needed to produce useful energy. For example, a careful analysis of the syncrude project indicates that at least one of every four barrels of oil produced in the tar sands must be used to run the plants; similarly, one of every ten units of natural gas going into an Arctic pipeline would have to be used to run the pipeline. It is this effect that doubled the share of energy going to the energy supply industry in the sixties, and that is responsible for part of our price inflation.

Understanding of the importance of energy costs has come slowly, for it is not just a matter of "plant efficiency", that is the fuel used in production. It also requires analysis of the energy content in the goods and services that make up the plant itself including, among other things, the energy used in mining, processing and transporting the primary products. This creates a seemingly infinite chain of effects. There are techniques based notably on energy input-output tables that can quantify the energy inputs. They are just now being developed for Canadian needs.

d) Environmental Costs

Despite our variety of background and local situations, as a nation we have a fairly uniform opinion of the kind of country we want as regards the quality and cleanliness of its air and water, and the healthfulness of the natural surrounding.

The activities associated with producing and using energy, and the waste products of energy conversion do have serious undesired effects on the quality of the atmosphere, waters and soils. Dangers exist to the health of our crops, livestock, forests, wildlife, and indeed to ourselves. Many of our activities connected with energy disturb the terrain and make the land unfit for other uses.

The effects of ignoring environmental considerations will be an impairment of the present and longterm productivity of the country, and a decrease in its perceived and real value for subsequent human use and enjoyment. In some areas this impairment has already happened.

Energy conservation is the purest form of environmental protection. This is especially evident in the long range perspective. To the extent that a unit of energy is conserved, a unit does not have to be produced, and entire supply projects can be cancelled or postponed for many years.

e) Employment

Inevitably, prices for energy are going to rise sharply. It will become clear to both industry and the general public that energy resources are no longer abundant and inexpensive. The result will be changes in inter-industry purchasing and changes in consumer spending habits. These changes will obviously transpose to the labour market, specifically through job dislocations. Unplanned rapid changes of great magnitude in the labour scene lead to severe strains. The transition from a war to peace economy is an example of the difficulties rapid changes spawn for labour. However, man is very malleable. He survived the war to peace transition. And by planning ahead, with a conserver society as the goal, it will be possible for the processes of change in labour to move so smoothly that the transitions will create a minimum amount of hardship while the benefits of change are maximized.

Empirical economic studies suggest that in the long run some of the benefits of change that we can expect to realize are industrial substitutions of labour for energy and labour for capital, (i.e. returnable bottles, furnace servicing, repairable goods, etc.). There is strong evidence to suggest that there could be an increase in employment as a result of a shift to a less energy-intensive society.

f) Conclusion

Energy conservation must be a major policy thrust for the future. This policy, however, does have some implications which are often missed. Notably, conservation of energy is not something to be introduced in a crisis and then dismissed; rather it has to become a long-term and essential component of Canada's policies and of Canadian lifestyles. Further, as one form of energy becomes less available, people will switch to less costly forms, creating tremendous pressure to expand the supply of the substitute source. Therefore, conservation must include all sources of energy, in all the regions of Canada plus all of its uses and all of the users. Transforming Canada into a conserver society will be a profound challenge to us as a nation and as a people, but it is a challenge we cannot ignore.

SECTION II

COMMITMENT

Management: What's in it for us?

In Canada, where industry and commerce consume about half of our annual energy supply, a considerable contribution to our national effort to conserve energy and cut inflation can be effected by increasing production efficiency. Faced with steadily increasing energy costs, product costs can be reduced by using energy more effectively. A reduction in product cost will allow for a reduction in price to the consumer and thus an increase in your share of the market.

To initiate an effective energy conservation program, a company must know how much energy enters and leaves its plant in a given period. To calculate the process energy requirements of your products, see the section on "How to Audit Energy". Although the initial energy audit may be time consuming and challenging, it will be well worth the effort. Manufacturing processes which use large amounts of energy will be identified and prime areas for conservation pinpointed.

Once the energy intensive processes are identified, one may concentrate on replacing old machinery and equipment, using more energy-conscious designs and improving maintenance programs.

By phasing in higher domestic oil prices, the government has accomplished its basic goal of cushioning the blow to the economy that resulted from the world-wide price increases. Time has been bought — time to switch from energy wasteful methods of production to energy efficient methods of production.

One of the basic tenets of the two-price system was the assumption that the federal government would be able to subsidize the cost of imported fuel through funds raised by the taxation of our petroleum exports. However, when the Canadian government decided to conserve fuel by limiting the amount of oil for exportation, the tax revenues from the lowered volume of oil exports were not sufficient to offset the payments made to the oil companies for imported petroleum and its products. A price hike would thus lower the compensation payments and generate capital for the oil industry's exploration projects in high-risk and low-return frontier areas. A continuing low price would also mean further subsidizing the rapid consumption of a non-renewable resource.

It seems logical to assume the pressures for higher prices will continue, because in the long run the dual price system will delay adjustments to the world price and cause a reduction in the efficiency of Canada's economic system.

It can be viewed as an exciting challenge. Those companies that move quickly to meet the challenge will contribute substantially to the solution of a national problem and assure themselves of a competitive position in the markets of the future.

Employees: What's in it for us?

In simple terms, without an energy conservation program, spiralling energy prices and a lack of easy availability of energy will lead to major shifts in the labour market. Indeed the end result may be an acute crisis for labour. A successful energy conservation program will make your company more competitive and your job more secure. In some cases it will also buy time for management to make changes that will involve substitutions of labour for energy.

Regardless of which sources of energy Canada chooses to use in the future, the costs of developing them and sending them to their market will be staggering. Canada's current conventional supply of petroleum is rapidly dwindling. In fact, Canada is already a net importer of oil. As the conventional supplies run out, Canada must turn to her less conventional sources, for example, tar sands oil and more remote Arctic and offshore oil. The implication of this shift is that inevitably, substantially more energy and capital will have to be spent to develop each successive unit of energy.

If energy demands continue to grow rapidly, Canada will be forced into the simultaneous development of several new sources of energy, all of a highly capital intensive and risky nature.

These shifts in capital from labour intensive secondary and tertiary industries to capital intensive primary industries involved in raw materials production, will necessitate major job dislocations throughout the Candian economy. This will in effect be a regressive step back to an economy based more on primary production and less on labour-intensive manufacturing and service industries. The implications for employment are obvious.

Today, energy conservation is a matter of economics; tomorrow, it is a matter of corporate survival. And you may be the one to determine whether an energy conservation program is a success or a failure. In this game, your job is the ante.

SECTION III

A CONSERVATION PROGRAM

This section describes the initiation and implementation of an energy conservation program for businesses. It should be used as a guide to design your own program, tailored to your company's requirements and capabiities.

We have included forms and charts for recording and reporting plant survey data and for tracking the progress of the program. The forms and charts are sample sheets that can be used directly or modified to fit your needs. They are designed to be removed from the center of the book and used as "masters" for duplication.

1) Essential Components

In the design of your energy conservation program, we strongly recommend six essential components:

- **The commitment of all the top management levels and unions to the goals of the conservation program.**

- **Monitoring the pattern of present energy use in your business,** as explained in the section "How to Audit Energy".

- **Implementation of those housekeeping measures which are indicated by surveys.** The results of your energy audit together with the checklists contained in Section VI of this book will indicate corrective action you should employ.

- **Consideration of new and appropriate technology from the point of view of energy efficiency and future costs.** We will deal with this in more detail in future publications.

- **The monitoring of improvements.** Record all changes in energy consumption on the tracking charts and tabulate the results. (see Chart 6)

- **Aggressive promotion of your energy conservation program to everyone in your business.** This includes communicating the results and benefits of the program to your employees and can extend to promotion of energy conservation in their own personal lives.

All of your individual requirements may not be anticipated by this format and some of the actions described may not be necessary or appropriate but you will find illustrated in this section the skeleton of a simple, workable energy conservation program.

2) An "Energy Audit"

The initial step in developing various strategies to save energy is to determine how much of the energy used is needed and how much is wasted. The measurement of energy flow requires an audit. An audit is a survey to provide information on total energy usage, how and where energy is used and the fuel intensity of output (BTU's per unit of output). Numerous forms of energy may be measured but each of these forms can be converted to British Thermal Units. (See conversion table, Chart #1.)

For your audit, you can literally create an audit balance sheet. (See section on "How to Audit Energy").The balance sheet categorizes process steps, the theoretical energy required to complete each step, the actual energy used, and the variance between theoretical and actual use. The idea is to set up goals each month to minimize the variance. (Chart #2)

If a small company has personnel or cost limits, your fuel supplier, machinery contractors or a consulting engineering firm can assist you in conducting an audit.

Without an energy audit, it is difficult and impractical to determine the most important measures to implement for your conservation plan. However, with an audit, you'll be aware of the possibility of creating an imaginative and productive conservation program.

3) Involvement

Management and Staff Participation

The key to establishing a successful energy conservation program is a genuine commitment from top management. Without this strong commitment and without the allocation of the needed resources, an energy conservation program will not work.

Responsibility for the program ultimately rests with the executive; implementation, however, begins with the managers.

4) Manager's Duties

a) The Manager's first task is to inform the line supervisors of the economic basis for conservation, and their accountability for the energy consumed in their areas of control.

b) Secondly, he must endeavour to establish a system in which the people who get the day-to-day work done, participate in deciding upon and carrying out the energy conservation program.

   This organization should consist of a coordinator appointed by management and representatives from each department in the plant forming a committee.

c) Thirdly, the manager must provide the conservation committee with guidelines so that they may:

   i) Formulate and conduct an energy audit;

   ii) Define the goals attainable;

   iii) Develop ideas on ways to save energy;

   iv) Enlist employee support and participation;

   v) Disseminate the collected information; and

   vi) Produce a standard energy accounting system.

5) Employee Participation

The success of any far-reaching conservation program is ultimately determined by the amount of involvement by the employees; the men who operate the machines, close the doors, turn off the lights.

a) The first suggestion is to have the staff participate in the energy conservation committee.

b) They should be consulted on the formulation and operation of the energy audit. Further employee participation should be solicited in many ways. Here are some suggestions:

   i) The distribution of literature and the showing of films on conservation;

   ii) Acknowledgement of goals accomplished;

   iii) Newspaper features and bulletins; and

   iv) A suggestion award plan.

c) Thirdly, the employees should be involved in the evaluation of the program. They should assist in reviewing the progress of the energy saving, help re-evaluate the original goals and reconsider and revise the program's goals as necessary.

The continued competitiveness of your organization depends in part on how effectively you use your energy supplies. The progress of your energy conservation program ultimately depends on the commitment from management and the enthusiastic participation of all employees.

SECTION IV

HOW TO AUDIT ENERGY

The meaningful plant conservation program begins with measurement. That is the measurement of all energy consumed in-plant during a fixed period of time.

To pinpoint precisely the energy input, the energy used, and the energy dissipated or wasted, requires a ready availability of in-depth data. To do this, you must have an energy balance sheet for every process and department. See (Chart 4 a) & b)).

In some instances, an energy audit will necessitate additional measuring capability (i.e. an in-line meter). This extra cost should quickly pay for itself.

1) How to Make an Energy Budget

An energy budget documents the relationship between the energy input and the work output. (See chart 2). If they are not equal, the difference is waste. No process or conversion will be 100% efficient. There is always some waste. For example the maximum efficiency of an internal combustion engine is limited by themodynamic principles. The goal, however, is to reduce waste to a minimum.

a) The total energy input must be measured. For the total plant, the energy audit will give this information but for a single process, additional metering must be available. (See chart 4 a) & b)).

b) The theoretical input must be calculated. (An example for a single process is given below).

c) The ratio of output to input is the efficiency. Also, the difference between input and output is waste. A feasibility study should then be carried out on the most wasteful processes to derive a cost/benefit evaluation for the reduction of this waste.

d) An approach to discovering major areas of wastage is suggested in chart 5.

2) An example of an energy budget for a single process

Suppose steel parts are to be washed at the rate of 100 lbs./hr. for 8 hrs. per day in a tank of hot water held at 150°F and with make-up water being added at the rate of 1 gal. per hour. (See Appendix B).

The tank is filled with 50°F. water at 7:00 a.m. Monday and heated to 150°F. in 1 hour. Its temperature is maintained until 5:00 p.m. Friday when it is dumped.

The theoretical energy input will be as follows:

— heat up water and tank	57,760 Btu
— wash steel (960 x 8 x 5)	38,400
— heat make-up (1000 x 8 x 5)	40,000
Total weekly heat required	136,160 Btu

If a meter were placed on this tank for a week, it might show that a total input of 1,243,760 Btu were consumed.

Therefore, the amount of heat lost, or wasted is: 1,243,760 - 136,160 = 1,107,600 Btu each week.

Therefore, 90% of the heat input is lost by radiation from the tank walls and by evaporation from the surface.

Obviously, this can be reduced by insulating the tank walls and by covering the top with plastic spheres especially made for this purpose.

The metered input of heat might be reduced to 329,810 Btu per week and thus the loss is: 329,810 - 136,160 = 193,650 Btu each week.

The total energy input is reduced by 913,950 Btu per week, or 73.5%.

3) First Survey — Housekeeping Actions

Your first survey should be aimed at energy wastes correctable through housekeeping actions. (See Charts 3 & 4.) Some examples of these are:

a) Inadequate insulation;
b) Machinery functioning when not in use;
c) Steam Leaks;
d) Unserviced or untuned furnaces;
e) Unnecessary heating; and
f) Unneeded lighting.

4) Second Survey — Processes, Departments & Products

The second step is to develop an energy report for each process, department and product. (See Chart 4 a) & b)). This report must specify:

a) The total input of energy in BTU's (excluding raw materials energy which we will deal with in supplemental publications);

b) The total number of units of each product turned out; and

c) The total conversion BTU is per unit of product.

5) Third Survey

After developing all the process energy balances you must carefully analyze them to determine whether;

a) Waste heat can be recovered to generate steam or electricity, to heat water or a raw material or heat space;

b) Processes may be discarded or altered to increase energy efficiency;

c) One should replace inefficient equipment and processes with energy efficient ones; and

d) Alternate energy sources with a more secure supply or renewable nature can be used.

6) Fourth Survey

The conservation committee must carry out an audit on week-ends and nights when the plant is not operational. This should determine the amount of energy used in non-working hours.

7) Fifth Survey

They must plan surveys of certain processes and equipment, for example: (See Chart 5)

a) The heating and air conditioning system;
b) Steam systems;
c) Electric motors;
d) Natural gas systems; and
e) Compressed air systems.

8) Implementation

The next step is the most important one. It involves implementing the energy conservation actions decided upon after the results of the audit have been thoroughly analyzed.

First of all, you must implement the necessary housekeeping measures which will correct the wastes identified in the first survey. (See Chart 3.)

Secondly, you must record all conservation projects that emerge from the analysis of the energy audits. Evaluate each project and select the most rewarding for immediate implementation. (See Charts 3 & 4.)

a) Calculate annual energy savings for each proposal.
b) Project future energy costs and calculate annual dollar savings.
c) Estimate proposals' capital or expense costs.
d) Evaluate investment merit of proposals using measures such as return on investment, etc. (See section on Return on Investment.)
e) Assign priorities to projects based on investment merit.
f) Select conservation projects for implementation and request capital authorization.
g) Implement authorized proposals.

9) Long Range Planning

Finally, you must reassess the design of all proposed capital projects from the point of view of energy efficiency. Keep in mind the future cost and the supply security of the type of energy you choose to run your plant.

10) Return on Investment

Supply figures for the following cost items of an installation designed to conserve or recover energy and insert in the formula to determine the Pay-back period, the Dollar Value of Savings and the Rate of Return on Investment.

FC = First Cost (Labour and Materials)
AOC = Annual Operating Cost (in dollars)
PFP = Projected Fuel Price (unit price at time of start-up)
EL = Estimated Lifetime (of equipment)
AFS = Annual Fuel Saving (in units)
S = Net Annual Saving (in dollars)
PP = Pay-back Period (in years)
DC = Depreciation Charge (dollars/year)
ROI = Return on Investment (in % per year)

Then:

$$S = AOC - (AFS \times PFP)$$

$$PP = \frac{FC}{S} \text{ (compare with expected lifetime of investment)}$$

$$DC = \frac{FC}{EL}$$

$$ROI = \frac{S - DC}{FC} \times 100\% \text{ (look for 15 - 20\% after taxes)}$$

$$\text{Simple calculation of ROI} = \frac{55\,(S - 10\%\ FC)}{FC}\ \%$$

This calculation, used by some firms, takes into account the amount of investment money left over after taxes (55%).

SECTION V

ARE YOU KEEPING UP WITH YOUR COMPETITORS?

What some companies are doing!

A major hotel and restaurant chain cut back on decorative lighting. It also provides customers with lower temperature hot water and shuts down escalators and some elevators during quiet hours.

One company has cut gasoline consumption by 20% with less frequent deliveries and a smaller fleet of trucks.

In Hamilton, a major steel producer has introduced a computer program to monitor the Company's energy flow.

In Ontario Hydro's new head office, a heating system uses three huge tanks to collect water which is circulated through the building, exchanging hot for cold to suit the conditions. It may save as much as $150,000 yearly.

One company has reduced hot water temperature to all restrooms and closed all draperies at night to reduce the cold from the glassed-in areas.

Another keeps all exterior doors, especially loading dock and garage doors, closed to reduce the unnecessary heat loss.

One has reduced elevator service after the normal working hours.

One company has reduced the workweek to 35 hours from November to March. They returned to the 40 hour week in March.

One company has removed tubes from every other fluorescent fixture in hallways and non-work areas. They state that the total kilowatt usage decreased by 15% so far over the last year.

Another has reduced the regular shift from 8:30 to 5:00 p.m. to 8:30 a.m. to 4:30 p.m. by limiting the lunch hour to 30 minutes, and there were very few complaints with most employees preferring the switch.

One company has relaxed the dress code to permit employees to dress for comfort according to the weather conditions.

Another has turned off half of the lights in the company parking lots.

One has the cleaning crew clean the office two hours earlier than normal, saving the two hours of light usage.

A manufacturing company gives employee cars with the most passengers the prime parking spaces — the fewer the people per car, the longer the walk to the office.

One utility company asked meter readers to shut off all car motors when taking readings.

Another company has begun a flexible time program. Employees can begin work any time from 7:00 to 8:30 in the morning and leave any time from 3:30 to 4:45 p.m. This way they can avoid the rush hour traffic that eats up gasoline.

One tire company has come up with a boiler that can burn old tires which, pound for pound, have about 50% more heating value than coal.

A major company reports that several offices around the country have done the following: "reduced the number of cooling towers used in the air conditioning system, caulked all window and air leaks, cut off steam and hot water on the week-ends, used decals on light switches that are color coordinated to be left off at all times or in the evenings, given the cleaning crew cards to leave as reminders on the desks of people who forget to switch off their lights, and many dress codes have been relaxed to permit "sport shirts in hot weather instead of tie and coats, and in the winter, it means warm sweaters and jackets"."

One Company is considering installation of a computerized system which will automatically reduce lighting by 85% when people vacate floors at 5:00 p.m. and 95% when janitors finish their work.

A pulp and paper company in B.C. generates most of its power from its own waste material, the remainder coming from B.C. Hydro.

One lumber company has made scrap lumber available for use for fireplaces and furnaces.

One transport company is sending out only fully loaded trucks and has lowered the gear ratios in tractors to burn fuel more economically at lower speeds.

Another company has turned off office lights at 5:15 p.m. instead of letting the clean-up crews do it at 10:00 p.m. in the evening.

One is given a $25 quarterly bonus to employees who turn in their parking lot sticker.

One major employer has plotted on a city map the areas where employees live and have posted the map on the company bulletin board. They have also posted city bus routes and schedules in hopes that fewer employees will drive to work.

One company is paying its employees a two dollar bonus for every dollar's worth of electricity and fuel saved in comparison to the company's electric and oil consumption from last year. It is hoped that this way the employees will turn off lights and keep the thermostat down.

Another is reimbursing each employee half of the fare paid for public transportation to and from work.

Chart 1

CONVERSION FACTORS

1 tonne	=	1,000 kg. = .985 long ton = 2,205 lbs.
1 cut. metre	=	35.3 cu. feet
1 metre	=	39.37 inches = 3.28 feet
1 tonne	=	300 U.S. gallons
1 tonne	=	7 barrels (bbls)
1 tonne/year	=	.02 bbls/day
1 barrel	=	42 U.S. gallons
1 barrel	=	35 Cdn. gallons
1 B.T.U.	=	1,054.8 joules
1 B.T.U.	=	1.0550 x 1010 ergs
1 B.T.U.	=	.252 kilogram-calories

FUEL	UNIT	B.T.U. ('000,000)
		Multiply by:
Cdn. bituminous	(short ton)	25.2
Lignite	(short ton)	13.2
Coke	(short ton)	24.8
Liquified Pet. Gases	(bbls of 35 Cdn. gal.)	4.095
Crude Oil	(bbls of 35 Cdn. gal.)	5.803
Motor Gas	(bbls of 35 Cdn. gal.)	5.222
Diesel	(bbls of 35 Cdn. gal.)	5.8275
Light Fuel Oil	(bbls of 35 Cdn. gal.)	5.8275
Heavy Fuel Oil	(bbls of 35 Cdn. gal.)	6.2874
Aviation Gas	(bbls of 35 Cdn. gal.)	5.0505
Aviation Turbo Fuel	(bbls of 35 Cdn. gal.)	5.4145
Natural Gas	'000 cu. ft.	1.07/1.0
Electricity	'000 kwh	3.4120

1 toe	=	107 kcal.
1 Mtoe	=	1013 kcal. = 3.968 x 1013 B.T.U.
1 million tonnes coal	=	.7 Mtoe
1 million tonnes coke	=	.67 Mtoe
1 million tonnes patent fuel	=	.7 Mtoe
1 million tonnes lignite briquettes	=	.48 Mtoe
1,000 million cu. metres natural gas	=	.9 Mtoe
1,000 million cu. metres manuf. gas	=	.42 Mtoe
1 Twh electricity	=	.086 Mtoe

1 tonne aviation gasoline	=	9.074 bbls
1 tonne motor gasoline	=	8.691 bbls
1 tonne kerosene	=	7.776 bbls
1 tonne gas/diesel oil	=	7.353 bbls
1 tonne lubricating oil	=	7.004 bbls
1 tonne heavy fuel oil	=	6.780 bbls
1 tonne Algeria-Sahara crude oil	=	7.713 bbls
1 tonne Kuwait crude oil	=	7.263 bbls
1 tonne Libya crude oil	=	7.593 bbls
1 tonne Venezuela crude oil	=	7.005 bbls
1 tonne average (others) crude oil	=	7.3 bbls crude oil = 1.034 toe
1 tonne natural gas liquids	=	10.919 bbls

refined products

1 tonne liquified petroleum gas	=	11.8 bbls crude oil = 1.193 toe
1 tonne aviation gas	=	8.9 bbls
1 tonne kerosene	=	7.73 bbls
1 tonne gasoline	=	8.53 bbls gasoline = 1.128 toe
1 tonne jet fuel	=	7.93 bbls jet fuel = 1.133 toe
1 tonne gas/diesel (distillate) fuel oil	=	7.46 bbls fuel oil = 1.095 toe
1 tonne residual fuel oil	=	6.66 bls fuel oil = 1.055 toe
1 cu. ft. natural gas	=	.028317 cu. metres

Chart 2

Industry: An Energy Budget

Energy use by consumption area and process steps	Actual Energy Used	Theoretical Energy Requirement	Variance between theory & practice	Goal	Change from Previous Month
Examples					
Buildings & Grounds					
Heating					
Shipping					
Lighting					
Machinery					
Receiving					
Laboratory					
Shop					
Assembly					
Combustion					
Waste Disposal					
Cooling					

Chart 3

DEPT.________ **ENERGY CONSERVATION SURVEY** DATE________

(Sample Sheet)

LOCATION	FUEL GAS or OIL LEAKS	STEAM LEAKS	COMPRESSED AIR LEAKS	CONDENSATE LEAKS	WATER LEAKS	INADEQUATE INSULATION	EXCESS LIGHTING	EQUIPMENT OPERATING UNNECESSARILY	BURNERS OUT OF ADJUSTMENT	UNNEEDED HEATING OR AIR COND	PHOTOCOPY MACHINE			DATE CORRECTED
SHIPPING														
RECEIVING														
LABORATORY														
SHOP														
ASSEMBLY														
CHEMICAL STORAGE														
COMBUSTION														
FURNACE ROOM														
UTILITIES														
ADMIN· OFFICES														

Chart 4

DEPT. ________

MONTHLY ENERGY USE BY DEPARTMENT

DATE ________

1976	ELECTRIC POWER			NATURAL GAS			FUEL OIL			COAL			COMPRESSED AIR			
	MWh	BTU/MWh	BTU	Mcu ft	BTU/Mcu.ft.	BTU	Gal	BTU/Gal	BTU	TONS	BTU/lb	BTU	Mcu ft	BTU/Mcu.ft.	BTU	
Jan.																
Feb.																
Mar.																
April																
May																
June																
July																
Aug.																
Sept.																
Oct.																
Nov.																
Dec.																
Total																

Chart 4A

DEPT. ________ **MONTHLY ENERGY USE BY DEPARTMENT** **DATE** ____________

1976	psig STEAM			Condensate Used or Lost			WATER			TOTAL CONVERSION BTU	No. of Units Produced	Conversion BTU Per Unit of Production	
	M lb.	BTU/M lb.	BTU	M lb.	BTU/M lb	BTU	M lb.	BTU/M lb	BTU				
Jan.													
Feb.													
Mar.													
April													
May													
June													
July													
Aug.													
Sept.													
Oct.													
Nov.													
Dec.													
Total													

Chart 5

SAMPLE OF AN ENERGY CONSERVATION CHECK LIST

Department ______________________________ Date ____________

STEAM SYSTEMS:

Steam at ______ psi, ______ pph winter peak, ______ pph summer demand.

1. Is steam being used at proper pressure for the application? ________
2. Is piping insulation adequate? ________
3. Are all steam traps operating properly? ________
4. Are additional steam traps needed? ________
5. Is all condensate returned to the boiler? ________
6. Can thermal fluids be used for more efficient heating? ________

Comments ______________________________

____

AIR MANAGEMENT SYSTEMS

1. Are proper temperatures maintained both summer and winter? ________
2. Is humidity control adequate for the operation? ________
3. Is the area properly insulated to minimize heat loss? ________
4. Are exhaust ducts located close to source of fumes? ________
5. Is provision for makeup air adequate? ________
6. Is exhaust from processes such as spray booths automatically controlled? ________
7. Can amount of exhaust air be reduced? ________
8. Is heat recovered from exhaust air? ________
9. Can heat loss be reduced from doors, windows? ________
10. Can timers control heaters, fans, chillers more efficiently? ________

Comments ______________________________

____

COMPRESSED AIR: Consumption _____ cfm at _____ psi.

1. Are there any leaks in compressed air piping? __________
2. Can small compressors handle after-hours loads? __________
3. Is compressed air properly dried at the compressor? __________
4. Is compressed air properly lubicated where needed? __________
5. Is oil-free air supplied where necessary? __________
6. Are compressed air pressures properly matched to the application? __________
7. Can lower pressure air be substituted for high pressure air? __________

Comments ____

____

ELECTRICITY

Voltages available __________ , peak electrical demand __________

Total hp induction motors __________ , power factor __________

1. Can peak demand be reduced by cycling non-critical loads? __________
2. Is power factor correction adequate? __________
3. Should synchronous motors be used on larger loads? __________
4. Is voltage adequate on all circuits? __________

Comments ____

____

LIGHTING: Lighting supplied by (no.) __________ (type) __________ fixtures rated at __________ watts.

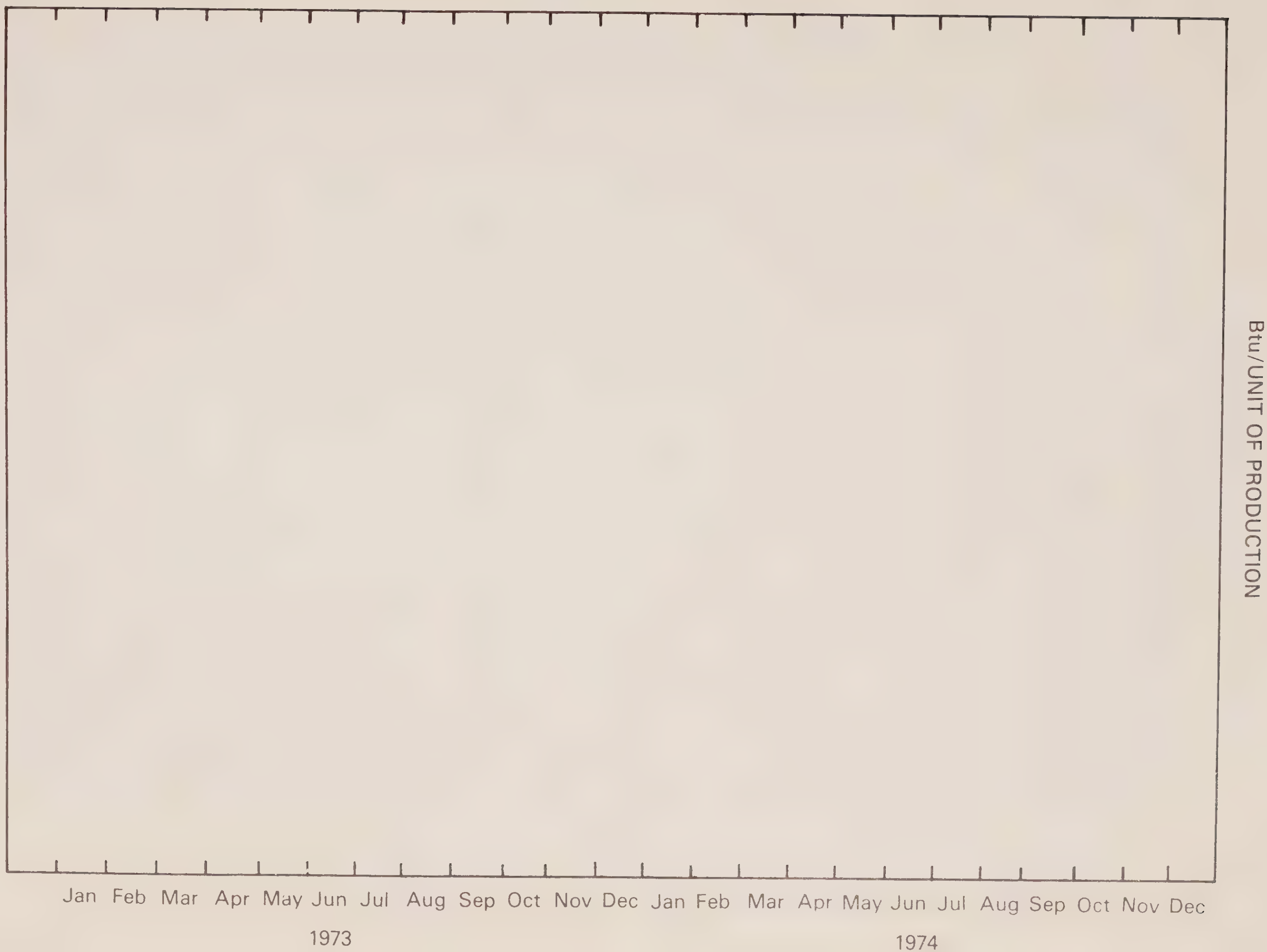
1. Is lighting level suitable for type of activity in the area? __________
2. Who is responsible for turning lights off when not needed? __________
3. Are lighting circuits designed to allow minimal safety lighting? __________
4. Can timers, photoswitches, control exterior lighting? __________
5. Can incandescent lights be replaced with more efficient types? __________

Comments ____

____

Chart 6

Tracking Chart
Energy Use Per Unit of Production



SECTION VI

ENERGY CONSERVING IDEAS CHECK LIST

1 INTRODUCTION

This is a brief list of some of the opportunities for energy conservation in business. However, each suggestion requires evaluating to determine whether it is feasible for a specific application. There is a possibility that some measures may be counterproductive or do not produce any net energy saving in your system.

These suggestions have been compiled from many different sources and if you have any ideas to contribute please pass them on to us.

2 HEATING AND AIR CONDITIONING SYSTEMS

AIR CONDITIONING

Turn off air conditioning in all unoccupied areas such as empty offices, hallways, conference rooms, etc.

Utilize humidity controlling systems which will allow the humidity to rise to the highest acceptable setting -- systems that use reheat are particularly beneficial.

Reduce or eliminate heat producing lights and/or appliances.

Leave storm windows and doors in place to prevent outside heat from coming in.

Be sure your air conditioning system is in good working condition by keeping filters, coils and blowers clean.

Insulate and ventilate crawl spaces in the roof and install an exhaust fan to draw out hot air.

Use water-cooled lighting fixtures if possible.

Use spot coolers when spaces are occupied only at various and irregular times.

If the office will be completely vacated after normal closing hours, turn off the air conditioning an hour before quitting time. The temperature will only increase gradually.

If possible use heat-producing equipment such as photocopiers in the early morning or late afternoon.

Awnings or shades can block out heat-producing sun rays.

Light colored walls on the south and west sides of your buildings will help reflect, not absorb, heat.

Urge employees to wear lightweight clothing to accommodate themselves to a slightly higher temperature.

Restrict employee smoking so you will not have to ventilate so much.

HEATING SYSTEMS

Discontinue humidity controls during non-working hours. Reduce the temperature in all public spaces such as lobbies, rest-rooms, hallways, etc. as people are usually in these places a very short time.

Operate ventilation systems only when necessary, not on a continuous basis.

Encourage the wearing of heavier clothing and permit women employees to wear slacks as the temperature is lowered in the office.

Be sure the heating equipment is in good operating condition and running smoothly — clean all air intakes and heat transfer surfaces. Have your furnace checked and tuned regularly.

If group work must take place after hours, ask employees to concentrate (if possible) in one heated area instead of scattering throughout the office or building.

Insulate all glass areas, including windows and doors, with caulking and/or storm windows and doors.

Insulate craw spaces and heating ducts against hot air leakage.

Install heat recovery devices in outgoing ventilation ducts to heat incoming air.

Install automatic ignition devices where pilot lights are used. Gas pilot lights in furnaces and boilers can use up to 24 cubic feet of gas per day.

Install automatic door closers or revolving doors to outside exits.

Drop the thermostat setting. Each degree lower, you save 3% of energy used. Set back thermostat further at night.

Do not allow the use of portable space heaters in the offices. Wattage use is high.

Keep all air grills clean.

Lower the water temperature in all the restrooms.

Check pipes and sinks for leaks.

Humidity should be kept high to increase comfort at lower temperatures.

3 BUILDINGS AND GROUNDS

SUGGESTIONS FOR IMMEDIATE ACTION

Reduce ventilation air.

Increase light reflectance of walls and ceilings.

Eliminate unused roof openings or abandoned stacks.

Reduce glazed areas in buildings.

Reduce temperature of service hot water.

Install timers on light switches in little used areas.

Close holes and openings in buildings such as broken windows, unnecessary louvers and dampers, cracks around doors and windows.

Repair faulty louvers and dampers.

Conserve energy by efficient use of water coolers and vending machines (i.e. shut them off at night).

Schedule use of elevators and escalators to conserve energy; use only one elevator and shut down escalator during offpeak times.

OTHER SUGGESTED ACTIONS

Reduce air conditioning load by evaporating water from roof.

Convert to fluorescent, mercury, sodium, or high intensity direct lighting.

Insulate walls, ceilings, and roofs.

Periodically calibrate the sensors controlling louvers and dampers on buildings.

Eliminate inefficient electric lamps from plant stocks and catalogues.

Clean air conditioning refrigerant condensers to reduce compressor operation time.

Use "heat wheel" or other heat exchanger to cross-exchange building exhaust air with make-up air.

Use photocell controls on outdoor lights.

Use building materials which require less energy to produce.

Size air handling grills, ducts, and coils to minimize air resistance.

Recover heat in waste service hot water.

Avoid introducing high moisture exhaust air into air conditioning system.

Use direct air supply to exhaust hoods.

Use exhaust heat from buildings for snow and ice removal from walks, driveways, parkways, parking lots, etc.

Use separate switches on perimeter lighting which may be turned off when natural light is available.

Use double or triple glazed windows to maintain higher relative humidity and to reduce heat losses.

Heat water during offpeak periods and store in well insulated containers for later use.

Use heat pumps for space conditioning.

Heat service hot water with air conditioning compressor exhaust.

Reduce or eliminate general lighting where natural light provides sufficient illumination. Limit higher lighting levels to task areas only.

Reduce exterior buildings and grounds illumination to minimum safe level.

Interlock heating and air conditioning systems to prevent simultaneous operation.

Recycle air for heating, ventilation and air conditioning to maximum extent.

Replace air curtain doors with solid doors.

Reduce solar heat gain by installing tinted or by tinting windows.

4 LIGHTING SYSTEMS

Use light colors on ceilings and walls, floors and furnishings.

Use efficient light sources by using the following chart:

INCANDESCENT LAMPS

40-watt general service lamp	=	11 lumens/watt
60-watt general service lamp	=	14.3 lumens/watt
100-watt general service lamp	=	17.4 lumens/watt
100-watt extended service lamp	=	14.8 lumens/watt
1,000-watt general service lamp	=	22 lumens/watt

FLUORESCENT LAMPS

2 x 24 in. cool white lamps produce 50 lumens/watt
2 x 48 in. cool white lamps produce 67 lumens/watt
2 x 96 in. cool white lamps produce 73 lumens/watt

HID LAMPS

400-watt phosphor coated mercury lamps produce 46 lumens/watt
400-watt metal halide lamps produce 74 lumens/watt
400-watt high pressure sodium lamps produce 100 lumens/watt
1,000-watt metal halide lamps produce 85 lumens/watt

Turn off all unnecessary lights (look around and see how many lights are on).

Reduce or eliminate decorative lighting inside and outside the building.

Lower the wattage of all lights where practical.

Open curtains and shades for more light during day light hours.

Keep bulbs and fixtures clean and free of light-blocking dirt.

5 TRANSPORTATION

KEEP SPEED DOWN

Tests conducted with popular American cars have indicated a 25% improvement in fuel economy when speeds are reduced from 79 to 59 mph. Wind resistance increases as car speeds increase and more energy is thus required to move the car at higher speeds.

AVOID "JACK RABBIT" STARTS

Gradual acceleration in city driving can save as much as two miles per gallon compared to rapid acceleration. That's because it takes a lot of extra energy to increase an automobile's accelation rate. A power valve located in the carburator lets more fuel into the cylinders under full acceleration. In addition, an accelerator pump provides extra fuel to avoid hesitation when the gas pedal is jabbed.

FUEL SAVING MEASURES

Lower the speed to a maximum of 50 or 55 mph.

Retrofit your trucks with streamlining spoilers.

Buy diesel fueled trucks.

Radial tires significantly lower rolling resistance.

Maintaining engine temperature at a higher level will result in 27% less wear and a 5% fuel saving for a gasoline powered engine.

The radiator shutter system can provide an 8-13% fuel saving over the thermatic fan system.

Encourage the use of double trailers.

6 ELECTRICAL POWER

SUGGESTED ACTIONS

Use combined cycle gas turbine generators with waste heat boilers connected to turbine exhaust.

Replace steam jets on vacuum systems with electric motor driven vacuum pumps.

Size electric motors for peak operating efficiency. Use more efficient type of electric motors.

Use power during off-peak periods. Store heated/cooled water for use during peak demand periods.

Use steam pressure reduction to generate power.

Use immersion heating in tanks, melting pots, etc.

Reduce load on electric conductors to reduce heating losses.

Optimize plant power factors.

Use by-product heat from transformers for service water heating.

De-energize excess transformer capacity.

Provide proper maintenance and lubrication of motor driven equipment.

Consider energy efficiency when purchasing new equipment.

Consider power loss as well as initial loads and load growth in sizing transformers.

Schedule operations in order to minimize electrical demand charge.

Use multiple speed motors or variable speed drives for variable pump blower and compressor loads.

Insulate tanks containing heated or cooled liquids by covering walls with insulation and open tops with hollow plastic spheres.

7 STEAM

SUGGESTIONS FOR IMMEDIATE ACTION

Turn off steam tracing during mild weather.

Maintain steam jets used for vacuum system.

Repair leaks in lines and valves.

Repair insulation on condensate lines.

Repair faulty insulation on steam lines.

Repair or replace steam traps.

Eliminate leaks in high pressure reducing stations.

KEEP SPEEDS CONSTANT

Driving at steady speeds helps to save gasoline Unnecessary acceleration activates the accelerator pump and power valve, thus injecting extra fuel into the system.

ANTICIPATE STOPS

It is best to plan ahead for all possible traffic conditions. This allows for gradual, rather than abrupt stops, and this smooth driving contributes to better fuel economy. In addition, gradual braking prolongs the life of brake linings.

PLAN ALL TRIPS

It is wise to plan all car trips to cover as many errands or deliveries as possible at one time. In city driving, a one-mile trip with the engine cold may decrease fuel economy by as much as 70%. Combustion is relatively inefficient in a cold engine, and the automatic choke must supply more fuel to keep a cold engine running smoothly. Longer trips which allow the engine to warm up result in better fuel economy.

AVOID ENGINE IDLING

An idling engine wastes energy; it does no useful work while consuming fuel. Excessive idling may also shorten engine life if the practice is repeated over a long-term period. As a guide, drivers hould not idle engines for more than three minutes,if possible.

WARM ENGINE BY DRIVING

Drivers will obtain better economy by driving the car to warm the engine rather than allowing it to idle excessively. This speeds up the warming process and thus saves gasoline. The driver must remember, however that a cold engine does not respond as quickly, so care must be exercised in all traffic situations where engine response is critical.

MINIMIZE THE USE OF AIR CONDITIONERS

Air conditioning puts a substantial load on automobile engines, and should, therefore, be used only on the hottest days. While driving at 30 mph the use of air conditioning can result in a fuel economy loss of two miles per gallon. As a rule, use of the air conditioner cuts gas mileage by 10%. Do you need an air conditioner? It adds extra weight whether you use it or not.

CAR WEIGHT

The one factor that has the greatest influence on gas consumption is the curb weight of the vehicle. The more it weighs, the poorer the mileage. Before you buy, find out the curb weight of each model you are interested in and work out rough mileages to be driven and fuel costs.

MAINTAIN CORRECT TIRE PRESSURE

Underinflated tires reduce gas mileage slightly. Soft tires also wear out quicker, and may adversely affect vehicle handling, thus creating a potential safety hazard. Many automobile manufacturers recommend increasing the tire air pressure by approximately four pounds before high-speed driving. Tires should not be inflated above the maximum recommended pressure. Radial tires also reduce rolling resistance and thus fuel consumption.

KEEP THE ENGINE TUNED UP

Spark plug misfiring may result in significant increase in fuel consumption. In laboratory tests at speeds of 30 and 50 mph, spark plugs misfiring 10% of the time resulted in an 8% increase of fuel consumption. In addition, deviation of ignition timing from the manufactuer's setting resulted in a significant decrease in fuel economy. For example, a 10-degree retard in basic spark timing may result in an average loss of 1.3 miles per gallon at speeds of 30, 50 and 70 mph. Drivers should be reminded that these and other obstacles to efficient engine performance can be eliminated with a complete tune-up.

SERVICE AIR FILTER

A dirty air filter can cause a decrease in fuel economy and a decrease in power output by restricting the flow of air to the engine. Service men should, therefore, be advised to change the air filter at specified intervals or according to the manufacturer's recommendations. In addition, frequent air filter servicing is required if considerable driving is done in sandy or dusty conditions.

LUBRICANTS

A properly lubricated engine means less friction between moving parts. Consult your maintenance manual for the proper lubricants to use and lubrication intervals.

AVOID GASOLINE SPILLAGE

Follow usual good practices at the pump island to prevent spillage and wasting of gasoline. For example, the attendant should avoid over-filling the vehicle's gasoline tank as is sometimes done by dispensing more fuel after the automatic nozzle has shut off.

DO NOT RIDE THE BRAKES

Even slight foot pressure on the brake pedal can apply the brakes, especially power brakes. This wastes fuel energy which might be used to move the car. It also wears the brakes out faster than normal.

KEEP TRANSMISSION IN HIGH GEAR

Keep both automatic and manual transmissions in the highest gear possible. With manual transmission, shift into high gear as soon as you can; with automatic transmission, use a light foot on the accelerator to encourage the transmission to shift into high gear quickly. These actions will save gasoline.

MINIMIZE VEHICLE LOADS

Transporting unnecessary weight in your car will cause it to use more fuel. The difference is not great on level ground, but does show up when climbing a hill and you will probably have to use your brakes more often.

SERVICE THE MANIFOLD HEAT CONTROL VALVE

The manifold heat control valve should be inspected and serviced periodically. This valve, located in the exhaust system of some vehciles, allows exhaust gases to heat the intake manifold during cold engine operation. These gases heat the areas under the carburettor to aid in the vaporization of gasoline while the engine is cold. As the engine warms up, a temperature sensitive spring causes the valve to direct all of the exhaust gases to the exhaust pipe and away from the intake manifold. A valve stuck in the open position causes slow engine warm-up and poor cold-engine performance. A valve stuck in the closed position will cause loss of power and hard starting with a hot engine. Sticking in either position makes the engine use more fuel.

WHEEL ALIGNMENT

"Toe in" or "toe out" has the effect of dragging your front tires sideways and causes premature tire wear. It takes power to carry this extra load and that takes gas from your tank.

FUEL SELECTION

Check to see if your car can use unleaded or low-leaded gasoline. Use of this type of fuel will reduce lead deposits and the possibility of spark plug fouling which can drastically reduce fuel economy.

AUTOMATIC CHOKE

Your automatic choke should be checked periodically as it regulates the gas/air mixture used in starting and warming the engine.

SHIPPING

Down truck engines while loading, unloading or waiting. Loading dock doors closed when not in use and eliminate lighting on top of stacked material. Install air seals around truck loading dock doors. Evaluate energy use in packaging.

BIG TRUCKS — Possible Fuel Savings

The following is a breakdown of how engine power is used.

	% of total power consumed
air resistance	45
drivetrain	13
rolling resistance	36
accessory	6

At 50 mph, 57 H.P. is required to overcome wind resistance.

at 55 mph	75 H.P.
60 mph	97 H.P.
65 mph	123 H.P.
70 mph	157 H.P.

A truck with a gross vehicle weight of 78,000 lb. will require

144 H.P. to over come rolling resistance at 50 mph
160 H.P. at 55 mph
172 H.P. at 60 mph
188 H.P. at 65 mph
200 H.P. at 70 mph

Cover condensate storage tanks.

OTHER SUGGESTED ACTIONS

Consider replacing electric motors with back pressure steam turbines and use exhaust steam for process heat.

Operate distillation columns at minimum quality requirements.

Operate distillation columns at near flooding conditions for maximum separation efficiency.

Determine correct feed plate location on distillation columns to increase efficiency and minimize steam consumption.

Consider switching selected steam stripping distillation units from direct (live) steam to indirect (dry) stripping.

Use correct size steam traps.

Flash condensate to produce lower pressure steam.

Evaluate replacing condensing steam turbine rotating equipment drives with electric motors, if your plant has a power generating capability.

Add traps to a distillation column to reduce the reflux ratio.

Insulate condensate lines.

Minimize boiler blowdown with better feedwater treatment.

Insulate steam lines.

Install steam traps.

Return steam condensate to boiler plant.

Use minimum steam operating pressure.

Use waste heat low pressure steam for absorption refrigeration.

Replace barometric condensers with surface condensers.

Shut off steam traps on superheated steam lines when not in use.

Optimize operation of multi-stage vacuum steam jets.

Use optimum thickness insulation.

Use reflux ratio control or similar control instead of flow control on distillation towers.

Substitute hot process fluids for steam.

8 OTHER UTILITIES

SUGGESTIONS FOR IMMEDIATE ACTION

Clean fouling from water lines regularly.

Shut off cooling water when not required.

Reduce business travel by using telephone when possible.

Conduct monthly audit of water meters for early leak detection.

Clean or replace air filters regularly.

Remove unneeded service lines to eliminate potential leaks.

Eliminate leaks in combustible gas lines.

Eliminate leaks in inert gas and compressed air lines and valves.

Eliminate leaks in water lines and valves.

Shut off all laboratory fume hoods when not in use.

OTHER SUGGESTED ACTIONS

Install adequate dryers on air lines to eliminate blowdown.

Install compressor air intakes in coolest locations.

Recover and reuse cooling water.

Do not use compressed air for personal cooling.

Use flow control valves on equipment to optimize water use.

Evaluate water cooling vs. air cooling for specific situations.

Eliminate cooling of process streams which subsequently must be heated and vice versa.

Shut off cooling if cold outside air will cool process.

Use cascade system of recirculating during cold weather to avoid sub-cooling.

Operate cooling towers at constant outlet temperature to avoid sub-cooling.

Use minimum cooling water to bearings.

Increase the level of the water in a drainage ditch to reduce the pumping head and horsepower required where drainage water must be pumped over a levee for disposal.

Reduce sewer liquid volume which reduces treatment energy by returning steam condensate to boilers.

Replace over-size motors and pumps with optimum size.

Reduce the pressure of compressed air to the minimum required.

Reduce hot water temperature to the minimum required.

Recycle treated water.

Eliminate compressed air drives from permanent installations.

9 HEAT RECOVERY

SUGGESTED ACTIONS

Use the overhead condenser to generate steam from condensates in a distillation process.

Use hot flue gases in radiant heater for space heating ovens, dryers, etc.

Use heat in flue gases to preheat products or material going into ovens, dryers, etc.

Use hot process fluids to preheat incoming process fluids.

Use hot flue gases to preheat wastes for incinerator boiler.

Use waste heat from hot flue gases to generate steam for processes or consider selling excess steam.

Use waste heat from hot flue gases to heat space conditioning air.

Use waste heat from hot flue gases to preheat combustion air.

Use engine exhaust heat to make steam.

Recover fuel value in polluted exhaust air.

Recover fuel value in waste by-product.

Use flue gases to heat process or service water.

Use oven exhaust for space heating.

Use recovered heat from lighting fixtures for useful purpose i.e., to operate absorption cooling equipment.

Use flue gas heat to preheat boiler feedwater.

Use cooling air which cools hot work pieces for space heating or make-up air in cold weather.

10 HEAT CONFINMENT

SUGGESTIONS FOR IMMEDIATE ACTION

Repair faulty insulation in furnaces, boilers, etc.

OTHER SUGGESTED ACTIONS

Use economic thickness of insulation for low temperatures.

Use soft insulation in cycling furnaces to facilitate heating up and cooling down.

Use minimum safe oven ventilation.

Upgrade insulation and linings in furnaces, boilers, etc.

Repair furnaces and oven doors so that they seal efficiently.

11 COMBUSTION

SUGGESTIONS FOR IMMEDIATE ACTION

Calculate and plot boiler efficiency daily.

Establish burner maintenance schedule.

Adjust burners for efficient operation.

OTHER SUGGESTED ACTIONS

Improve combustion control capability.

Heat oil to proper temperature for food atomization.

Eliminate combustible gas in flue gas.

Reduce combustion air flow to optimum.

Convert combustion to more efficient fuel.

Replace obsolete burners with more efficient ones.

Use waste and by-products as fuel.

Limit and control secondary combustion air in furnace operations to the amount required for proper furnace operation.

12 SCHEDULING

SUGGESTIONS FOR IMMEDIATE ACTION

Shut down process heating equipment when not in use.

OTHER SUGGESTED ACTIONS

Indicate causes of electrical power demands and peak charges and reschedule plant operations to avoid peaks.

Reduce temperature of process heating equipment when on standby.

Use most efficient equipment at it's maximum capacity and less efficient equipment only when necessary.

Heat treat parts only to required specifications or standards.

Schedule routine maintenance during non-operating periods.

Consider three or four days around-the-clock operation rather than one or two shifts per day.

Minimize operation of equipment required to be maintained in standby condition.

Reduce operating time of equipment to that actually required.

Optimize production lot sizes and inventories.

13 MATERIALS HANDLING

SUGGESTIONS FOR IMMEDIATE ACTION

Turn off conveyors, lift trucks, etc., when not in use.

Recharge batteries on materials handling equipment during off-peak demand periods.

Adjust and maintain fork lift trucks for most efficient operation.

Shut down diesel construction equipment when not needed.

OTHER SUGGESTED ACTIONS

Use optimum size and capacity equipment.

Upgrade conveyors.

Use gravity feeds wherever possible.

14 PROCESS CHANGES

OTHER SUGGESTED ACTIONS

Schedule baking times of small and large components to minimize use of energy.

Use vapor recompression design in distillation processes.

Use "side draw" principle in distillation column design.

Use continuous equipment which retains process heating conveyors within the heated chamber.

Use direct flame impingement or infrared processing for chamber type heating.

Convert from indirect to direct firing.

Convert from batch to continuous operation.

Use shaft type furnaces for preheating incoming material.

Convert liquid heaters from underfiring to immersion or submersion heating.

Minimize unessential material in heat treatment process.

Change product design to reduce processing energy requirements.

Reduce scrap production.

Upgrade obsolete or little used equipment.

APPENDIX A

Incentive Programs Available to Support Energy Conservation in Industry

To support energy conservation measures in industry, including waste heat recovery, the Department of Industry, Trade and Commerce is administering its existing PEP (Program to Enhance Productivity) and PAIT (Program for the Advancement of Industrial Technology) to ensure that they support energy efficiency. Brief descriptions of each program are set out here. If a project can demonstrate the possibility of significantly improving energy efficiency and if it meets the other criteria of the programs, assistance may be granted.

1 PAIT

The basic purpose of the PAIT Program is to promote the growth and efficiency of industry in Canada by providing financial assistance for selected projects concerned with the development of new or improved products and processes which incorporate new technology and offer good prospects for commercial exploitation in domestic and international markets.

Financial assistance under the program is available to companies incorporated in Canada for development projects to be carried out and exploited in Canada. Costs of an approved project are shared by the Department and the company concerned.

Consideration is given to applications for PAIT assistance from individual companies, or from groups of companies proposing to support jointly a development project. It is not the purpose of the program to finance the acquisition of general purpose capital facilities. Companies are expected to have or to acquire the capabilities, facilities and other resources required not only to undertake the development work but also to manufacture and market the resulting product or use the resulting process. However, companies may subcontract portions of the work to other companies, research institutes, universities, or consultants, where this is considered desirable.

Responsibility for proposing development projects and assessing their technical and commercial feasibility rests with industry, as does the responsibility for the subsequent direction and execution of the development work. The Department appraises applications against a number of selection criteria and monitors the progress of those projects which are approved for support. To qualify for support, projects should involve a substantial technical effort.

Companies are required, within a reasonable time, to exploit the results of the development project in the domestic and export markets, from a manufacturing base in Canada, to the extent that it is not uneconomic to do so.

Title to patents, designs, technical data, and materials resulting from a project vests in and remains the property of the company. However, companies must undertake not to transfer technical data or inventions, methods or processes resulting from the development project to anyone for the purpose of producing or manufacturing outside Canada end products identical to or substantially the same as the products resulting from the development project without the consent of the Minister.

It should be noted that normally the program does not cover costs incurred before the Department agrees to support a project.

Cost Sharing

As a rule the Department contributes on a grant basis up to 50 per cent of the total estimated cost of approved development projects, without profit or fee to the applicant, by making monthly progress payments as costs are incurred by the company, in accordance with the provisions of the Assistance Agreement.

If the company sells or transfers to commercial use any prototype, pilot plant or other equipment, the costs of which were charged to the PAIT project, the company may be requied, at the discretion of the Minister, to repay to the Crown, in the ratio of their respective contributions, the proceeds of sale or the fair market value of the prototype, pilot plant, materials, or equipment, whichever is greater, but the Crown's share shall not exceed the Crown's contribution to the project.

Eligible Activities

Financial assistance is provided under the program for current expenses which are essential to the development of new or improved products or processes (e.g., direct labour, direct material, subcontracts and consultants, overhead) including industrial design services and the costs of construction prototypes, pilot plants and special test equipment. In addition, the following pre-production expenses are eligible for support where they are related directly to the commercial exploitation of the results of the development project: the preparation of production drawings, process data, reports, specifications, instructions and bills of material, and the design of production tooling, inspection and test equipment, and other non-recurring pre-production activities of similar nature.

The PAIT Program provides support to activities undertaken directly for the purpose of defining the specifications of the products or processes to be developed with a PAIT project, and for assessing the prospects of exploiting them commercially. Consequently, the various activities required to analyze market conditions and criteria, product specifications and costs, and commercial feasibility may now be included as integral segments of PAIT projects. Depending upon the circumstances, such functions might include: market research, which would range from analyses of published data to acceptance testing; estimating distribution expenses; production costing; investigation of trade standards; analyses of competitive situations; determination of the required range in product size, performance; estimates of cash flow, working capital and return on investment calculations.

While most market or commercial assessments will be done at the beginning of a project, at times it may be desirable to conduct certain analyses concurrently with the technical development. Such studies might be to refine, up-date, or confirm earlier assessments, in light of technical results, market changes or prototype evaluations.

Capital costs incurred for the acquisition of general purpose facilities and equipment, and expenses related to production and marketing activities are not eligible for support under the program.

Treatment Under the Federal Income Tax Act and The Industrial Research and Development Incentives Act (IRDIA)

Section 72 of the federal Income Tax Act allows a taxpayer to deduct when computing income for tax purposes, all expenditures of a current nature made in Canada for scientific research, and all expenditures of a capital nature made in Canada for scientific research, and all expenditures of a capital nature made in Canada (for the acquisition of property other than land) for scientific research, in the year in which they were incurred. Accordingly, a company may claim its share of the costs of the development portion of a PAIT project as a deduction from income under Section 72. Depending on the nature of the pre-production expenses related to a PAIT project, a company may claim its share of these costs under other sections of the Income Tax Act.

For further information on the program contact:

PAIT Program Office
Department of Industry, Trade and Commerce
112 Kent Street
Ottawa, Ontario K1A 0H5

2 PEP

Program Objective

The objective of the PEP Program is to induce improved productivity in manufacturing and processing industries in Canada by means of contributions to encourage companies to undertake intensive studies of significant and imaginative efficiency-improved projects.

Form of Assistance

PEP offers a grant of a specified amount up to a maximum of $50,000 to support up to 50 per cent of the approved costs of a feasibility study. These costs are defined as salaries and wages for direct labour and an allowance for other administrative and operational costs. Fees incurred through contract for consultants are also included. Capital costs of any kind are excluded.

The contribution by the federal government will take the form of a series of monthly payments to be made to the applicant after the allowable costs have been incurred. Repayment is not required.

Program Intent

PEP is intended to foster the conduct of studies which have the potential to lead to high productivity improvement projects but which, without support, likely would not be undertaken. Such a project would have been developed to the stage where the possibility of a new approach being achievable appears reasonable but the information base is inadequate for purposes of decision taking and the cost of obtaining such information is such that the company without assistance will not proceed with the project. Conversely, it is intended that the program not assist in the conduct of studies which would likely have been carried out in any event.

PEP is also designed to spark innovation as it applies to the production phase of manufacturing and processing and not as it applies to the product or process research and development phases.

If the feasibility study requires that a market analysis be conducted, the cost of the market analysis portion would not normally be expected to exceed 25 per cent of the total cost of the study.

Should a company requesting PEP assistance propose to employ the services of a non-Canadian consulting firm or resident in the conduct of the study, it must provide reasons satisfactory to the Department that the work could not be carried out equally well by a Canadian consultant.

No retroactive funding will be considered. Formal commencement of the study for which funding is being sought must not have occurred at the time that funds are granted by the Department.

Eligibility Criteria

In submitting the application, the applicant should be aware of the appraisal criteria which will be applied and should establish that he meets these criteria:

(a) It must be demonstrated that:

- (i) the project involves a significant departure from the company's traditional productivity improvement practices, and also involves only existing available technology.
- (ii) there exists a marked but unproved potential for significant productivity gains but demonstratable uncertainty as to the profitability of the project, and
- (iii) a feasibility study is required before a decision can be made concerning implementation of the project.

(b) It must be demonstrated that successful completion of the project under study is likely to result in all or at least some of the following benefits to Canada:

- (i) greater industrial strength and improved international competitiveness.
- (ii) expansion of sales and production in high productivity operations, and
- (iii) satisfactory return on production and sales associated with the use of what would otherwise be idle resources.

leading to more stable and continuous industrial activity, support to external payments viability, or other beneficial side effects.

(c) To be eligible for assistance, a company must also:

- (i) be incorporated in Canada and be actively engaged in manufacturing or processing.
- (ii) have the financial resources to undertake its portion of the study, and
- (iii) satisfy the Departmental committee that it has, or is able to acquire, the financial, administrative and manpower resources, and the physical facilities, needed to implement the project which is the subject of the feasibility study.

Company Obligations

(a) The company must submit an application demonstrating that the feasibility study meets the program eligibility criteria.

(b) Upon execution of the PEP Agreement, the company is responsible for organizing, directing, and executing the work and is also responsible for monthly submissions of certified progress claims forms required for Her Majesty's monthly disbursement of monies contracted. The company will in addition permit a Departmental representative to have access to their premises to inspect and assess the progress of the work, and to audit costs when considered necessary.

(c) Upon completion of the feasibility study, the company will be required to submit to the Department the findings and recommendations of the study; and one year thereafter, the information deemed sufficient for the Department to assess the savings to be realized by the company as a result of the study.

Agreement

The provisions of PEP's financial assistance for an approved feasibility study shall be covered by a standard Assitance Agreement in the form set out in Appendix II. A Statement of Work, agreed to by the company and the Department, will be appended to and will form a part of the Assistance Agreement.

Recognizing that development plans and activities have a vital bearing on a company's competitive position, and information thereon is proprietary, the Department will treat all information provided by the applicant in confidence.

Applicant Procedure

An applicant must submit three copies of a completed PEP Application Form to formally request a contribution under this program. Prior to submission of this application, the applicant is strongly urged to consult with Departmental representatives who will be able to provide additional information and advice on the preparation of the application.

Application Forms and further information are available from:

PEP Program Office
Department of Industry, Trade and Commerce
112 Kent Street, Ottawa, Ontario K1A 0H5

APPENDIX B

EXAMPLE OF AN ENERGY BUDGET THEORETICAL CALCULATION

For the purpose of this example it is assumed you are endeavouring to ascertain the energy consumed by a water wash tank in the plating room.

The tank is filled and heated every Monday morning in 1 hr. starting at 7 a.m. and maintained at 150° F. until it is drained on Friday afternoon at 5 p.m. (a total of 106 hours). This happens 50 times a year.

The work load of the tank (i.e. parts washed) amounts to 100 pounds of steel per hour. The parts are immersed in the water for 1 hour, entering at 70° F., 8 hrs./day.

The tank is 2 feet wide, 3 feet long and 2 feet deep.

The water depth is 1 ½ feet and is maintained at this depth by adding make-up water at the rate of 1 gallon per hour. Fresh water temperature is 50° F. The ambient temperature is 70° F.

The total theoretical energy input to the dipping tank is calculated for two conditions.

1. tank walls uninsulated and no cover on top.
2. tank walls insulated with 1″ of foamed polystyrene and top covered with plastic spheres.

PHYSICAL CONSTANTS

Water:	sp. ht.	— 1.0 btu/lb/°F.
	heat of fusion	— 140 btu/lb.
	heat of vaporization	— 960 btu/lb.
	density	— 62.4 lbs/cu. ft.
Steel Tank:	sp. ht.	— .12 btu/lb/°F.
	density	— 492 lbs/cu. ft.
	thickness	— 1/8 inch

WEIGHTS & AREAS

Volume	= 2′ x 3′ x 1½′	= 9 cu. ft.
Wt. of water	= 9 x 62.4	= 561.6 lbs.
Area	= 3(2 x 3) + 2(2 x 2)	= 26 sq. ft.
Wt. of tank steel	$= \frac{26 \times .125 \times 492}{12}$	= 133.3 lbs.
Top area	= 2′ x 3′	= 6 sq. ft.

A. HEAT-UP REQUIREMENTS

Fundamental formula:

Weight (lbs) x sp.ht. (btu/lb/°F.) x temp. rise (°F.) plus
Weight (bls) x Heat of Fusion/Vaporization (btu/lb.)

				Tank: Uninsulated btu	Insulated btu
Start-up heat absorbed by:					
Water	= 561.6 x 1.0 x (150° — 50°) + 0			56,160	56,160
Tank Steel	= 133.3 x .12 x (150° — 50°) + 0			1,600	1,600
	Total absorbed			57,760	57,760
Losses* from:		Uninsulated	Insulated		
Tank sides	26 sq. ft. (a)	188 btu/sq. ft.	28 btu/sq. ft.	4,900	730
Water surface	6 sq. ft. (a)	917 btu/sq. ft.	228 btu/sq. ft.	5,500	1,370
	Total losses per hour			10,400	2,100
Working heat absorbed by:					
Steel parts	= 100 lbs. x .12 x (150° — 70°) + 0			960	960
Make-up water	= 10 lbs. x 1.0 x (150° — 50°) + 0			1,000	
Make-up water	= 2.5 lbs. + x 1.0 x (150 — 50) + 0				250
	Total input per hour			1,960	1,210
OPERATION					
Heat up	— absorbed in first hour			57,760	57,760
	— average loss in first hour	$\frac{\text{total losses}}{2}$		5,200	1,050
Working	— input per hour x 8 hr x 5 days per week			78,400	48,400
	— losses per hour x 106 hours per week			1,102,400	222,600
Total energy input per week				1,243,760	329,810
Potential Weekly Saving		(73.5%)			913,950

**available from published curves*
+ evaporation reduced by covering